

WSR-88D Tropical Cyclone Operations Plan

Current for Open RPG System: 07/18/2003

- This plan was designed to be used as an *operational reference* only. Local modifications to the plan will likely be required. Be sure to consult with your local Unit Radar Committee (URC) in advance concerning any changes which result in system wide modifications. Pre-hurricane URC agreements will allow changes to be made operationally as needs arise.
- Note that by default the 8-level 0.54 nm Velocity product and the 0.54 nm Composite Reflectivity product are not available to Class 2 (non-associated or dial) Users according to the baseline product set defined in the current Guidance on Adaptable Parameters (WSR-88D Handbook Volume 4, RPG). (See <http://www.roc.noaa.gov/ssb/sysdoc/Operations.asp> .) However, these products can be made available by modifications to the RPG Product Generation Table and RPG Product Distribution Control Table (step 4, below).

Note: While temporary additions of these products can be made on-site, each time the RPG is rebooted or the VCP/weather mode is changed, the lists will be replaced with the baseline. Therefore, it is suggested that the site request the Radar Operations Center (ROC) Hotline to make the product additions to the baseline for the duration of the tropical event. Ensure that a telephone line is available to your MSCF's modem in order that the ROC can make necessary changes.

- The most important part of this plan for both Class 1 (associated) Users and Class 2 (non-associated) Users is the availability of and changes associated with the 8-data level Velocity product (steps 3, 4, and 11). The advantage of using the 8-level Velocity product is that the maximum wind field can be displayed, while leaving the standard 16-level Velocity product (-64 kt to +64 kt) alone for routine use.
- Record your local "default" adaptable parameters before implementing any changes. After the tropical cyclone threat has passed, return all parameters back to their proper "default" values. Refer to the current Guidance on Adaptable Parameters (WSR-88D Handbook Volume 4, RPG) for system wide defaults.
- "Levels of change authority" require steps 4 and 11 to be performed for the WFO by the ROC Hotline. Ensure a telephone line is available to your MSCF's

modem, and allow up to a half hour for the ROC Hotline to make the changes (i.e. contact the ROC Hotline well prior to rainband impact). All other changes are performed by the WFO using the URC level of change authority. Once the tropical cyclone event has passed, contact the ROC Hotline to return ROC password controlled adaptable parameters to their default values.

- For questions or comments that need an immediate response, contact the WSR-88D Hotline at the Radar Operations Center. Other questions about this document can be addressed to Colin McAdie (Tropical Prediction Center) or Dan Berkowitz (Radar Operations Center).

At the WSR-88D RPG Human Computer Interface (HCI):

Note: All commands for steps 1-12 begin from the HCI RPG Control/Status window and may require URC level password. Steps 4 and 11 require ROC level passwords, and the ROC Hotline must be contacted.

1. Well prior to the onset of tropical cyclone rainbands, ensure that the RDA emergency power generator fuel level is maximized. It may be several days before commercial power is restored in the aftermath of a significant tropical cyclone and fuel delivery will likely be delayed.

- From the **Applications** menu, select **RDA Performance Data**, then select **Tower Utilities**
(check % of **Gen Fuel Level**)

2. Operational mode - Use VCP 11 for better vertical resolution and faster data refresh. A switch to VCP 21 can be made if load shedding becomes a concern.

- Select **VCP Control Panel/Window**, then select **CHANGE to RDA VCP: 11**
(Note: Wait until 0.5 degree scan completes before executing the command).
- Confirm and **Close**

This command invokes a "local" VCP as defined in the RDA adaptation data. Local VCP 11 (and 21) are defined with a .97 kt Velocity Measurement Increment (VMI) which limits velocity measurements to ± 123 kt and a 5 PRF selection which restricts the unambiguous range to 79 nm. To modify the unambiguous range to 94 nm, or to change the VMI to measure winds in excess of ± 123 kt, refer to steps 10 and 11, respectively.

3. Velocity data (display) levels for the 8-data level products should be set to display

hurricane force winds. Note the default settings for the 16-data level Velocity products display a maximum of 64 kt, which will be exceeded by even a minimal Category 1 hurricane. Begin with the suggested values, then adjust accordingly to best display the maximum wind field.

Note: Before making changes, record values currently being used; these will be needed after the storm passes.

- From the RPG **Products** menu, choose **Selectable Parameters**, then select **Category: Velocity Data Levels**
- Select Velocity Table **Precip 8 / 0.97** and change Code 7 to **100** and Code 6 to **80**
- Select Velocity Table **Precip 8 / 1.94** and change Code 7 to **135** and Code 6 to **115**
- **Save**, confirm changes, and **Close**

This modifies the 8-level Velocity products **ONLY**. The routine 16-level Velocity products are not affected. By entering the values above, corresponding negative values are automatically supplied.

Table "Precip 8 / 0.97" ("Precip 8 / 1.94") will be used if the Velocity Measurement Increment (VMI) is .97 kt (1.94 kt). Refer to step 11, below.

4. Allow NWS National Centers, such as TPC, and other non-associated (Class 2) display systems, access to:

- a.) **8-data level 0.54 nm Velocity (V) product** (product #24)
- b.) **0.54 nm Composite Reflectivity (CR) product** (product #37)

These products should be added to both the RPG Product Generation Table and the RPG Product Distribution Control Table.

***** Note: A permanent change requires ROC level of change authority - contact the ROC Hotline. While these changes can be made to the Current RPG Product Generation Table and the Current Product Distribution Control Table using URC level of change authority, *any RPG reboot or weather mode change will restore "default" settings, removing the product #24 and #37 additions.* *****

- From the RPG **Products** menu, select **Generation List** to obtain the RPG Product Generation Table Editor list.
- Select **Current**
- Change the Code **#24** (Base Velocity: 8 level/0.54 nm) row as follows: **Gen** to **1**, **Arc** to **0**, **Sto** to **1**, (**mins**) to **60**, and **Cut(s)** to **-4**

- Change the Code #37 (Composite Reflectivity: 16 level/0.54 nm) row as follows: Gen to 1, Arc to 0, Sto to 1, and (mins) to 60
 - Save, confirm changes, and Close
 - From the USERS Products menu (Product Distribution Control menu), place a check mark under A for codes 24 and 37
 - Save, confirm changes, and Close
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5. The Threshold Pattern Vector (TPV) within the Mesocyclone algorithm should be reduced to 6 to improve detection of small diameter features; however, a greater number of false alarms will also be generated.

Note: The Mesocyclone and Tornado Detection algorithms began to process data separately starting with WSR-88D Build 10. Steps 5 and 6 will independently increase the radar's detection efficiency for small, shallow circulations.

- From the RPG Products menu, choose Algorithms, then select Adaptation Item: Mesocyclone
 - Change Min # Pattn Vec value from 10 to 6
 - Save, confirm changes, and Close
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6. Several "default" parameters within the Tornado Detection Algorithm (TDA) should be changed to increase the probability of detecting weak or distant tornadoes; however, a greater number of false alarms will also be generated. For more information see "Spratt, S. M., D. W. Sharp, P. Welsh, A. Sandrik, F. Alsheimer, and C. Paxton, 1997: A WSR-88D assessment of tropical cyclone outer rainband tornadoes. Wea. Forecasting, 12, 479-501. Copyright 1997 by AMS."

- From the RPG Products menu, choose Algorithms, then select Adaptation Item: Tornado Detection
 - Change Minimum 3D Feature Depth from 1.5 to 2.0
 - Change Min 3D Feat Low-Lvl Delta Vel from 25 to 14
 - Change Minimum TVS Delta Velocity from 36 to 44
 - Save, confirm changes, and Close
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7a. Change the "default" (convective) Z/R relationship ($300R^{1.4}$) to the "tropical" Z/R relationship ($250R^{1.2}$) to provide better precipitation estimates. Switching to the "tropical" Z/R will increase the estimated precipitation accumulations, especially for higher reflectivities.

Note 1: Closely monitor rainfall accumulations relative to ground truth observations. If the Z/R relationship is changed too far in advance of the tropical cyclone rainbands, the radar will overestimate totals associated with pre-landfall convection.

Note 2: An AWIPS program can be run in real time to create parallel versions of radar precipitation products using different Z-R relationships; i.e. you can create OHP, THP and STP products locally on AWIPS with the tropical Z/R and compare them in real time with the (default Z/R) products from the RPG. To get more information on this program, go to the AWIPS Local Application's web site (<http://www.nws.noaa.gov/mdl/awips/>) and then select Applications Database.

- From the RPG **Products** menu, choose **Algorithms**, then select Adaptation Item: **Hydromet Rate**
- Set **Z-R Multiplier Coef. [CZM]** to **250**
- Set **Z-R Exponent Coef. [CZP]** to **1.2**

7b. MXPRA (Maximum Precipitation Rate Threshold) should be increased to allow for greater rain rates. A MXPRA of **150** mm/hr (**6** in/hr) should be sufficient during most tropical cyclone situations [The ROC recommends that the MXPRA never be set higher than 200 mm/hr (7.9 in/hr)]. If the MXPRA is not adjusted, the default value will only allow for a maximum rate of **103.8** mm/hr (**4.1** in/hr). See the current Guidance on Adaptable Parameters (WSR-88D Handbook Volume 4, RPG], page 8-15, section 8.8.1 for more information.

- Set **Max Precipitation Rate** to **200** mm/hr (7.9 in/hr)
 - **Save**, confirm changes, and **Close**
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8. Ensure that minimal clutter suppression is in effect. This will improve rainfall estimates and overall algorithm performance. If significant clutter or anomalous propagation (AP) becomes apparent, return to a greater Clutter Suppression Region (CSR) file.

- From the **Applications** menu, select **Clutter Regions**
- Select **File**, then double-click on **11** (assuming clutter suppression region 11 is a pre-built minimal suppression file)
- **Close**, **Download**, confirm download, and **Close**

If you need to "build" (then download) a minimal CSR, the following commands will produce one with the bypass map in control and with medium suppression applied to known ground targets.

- From the **Applications** menu, select **Clutter Regions**
- Select **File**, then double-click on **Default**

- Edit both the **Segment: Low** and **Segment: High** tables to agree with the one below.
- **Save As**, give this file a name (e.g., **11**), **Accept**, **Close**, then **Download**, confirm changes, and **Close**

Example of a minimal Clutter Suppression Region (file 11)
Bypass map in control

Region:	Azi1 (Deg)	Azi2 (Deg)	Ran1 (NM)	Ran2 (NM)	Select Code	Dopl Chan	Surv Chan
1	0	360	1	275	Bypass Map	Medium	Medium

9. Adjust precipitation data display levels if the potential for extremely heavy rainfall exists [maximum displayable values: 12.7 inches for One Hour Precipitation (OHP) and Three Hour Precipitation (THP), and 25.4 inches for Storm Total Precipitation (STP) and User Selectable Precipitation (USP)].

- From the RPG **Products** menu, choose **Selectable Parameters**, then select **Category: OHP/THP Data Levels**
- Change Codes 3 through 16 as desired for the current event
- **Save** and confirm changes
- Select **Category: STP Data Levels**
- Change Codes 3 through 16 as desired for the current event
- **Save**, confirm changes, and **Close**

10. Remember that RPG HCI operators have the ability to move the maximum unambiguous range (R_{max}) out to a maximum distance of **94 nm** or in to a minimum distance of **63 nm** by adjusting the PRF. This may become necessary to improve velocity products as the tropical cyclone approaches. The "Download" command invokes a "Remote" VCP, with VCP 11 (and 21) defined with a PRF of 4 ($R_{max} = 94$ nm).

Note: The TPC prefers the maximum R_{max} as often as possible. However, local needs may dictate otherwise, and will take precedence.

- Select **RDA Control**
- Select **VCP** in the Control/Status window
- Toggle Auto PRF **Off**
- Under Download VCP from RPG, select **11**
- Confirm and **Close**

Note: Wait until the 0.5 degree scan completes before executing the download command. As long as the Auto PRF is off, the unambiguous range will remain at 94 nm.

11. If velocities are expected to exceed **124 kt**, increase the Velocity Measurement Increment (VMI) from .97 kt to 1.94 kt.

***** Note: While these changes can be made to the Current VCP, whenever other changes are made to the VCP, the original VMI will be restored. Changes to Adaptation VCPs must be made by the ROC Hotline. *****

- With the **Auto PRF** remaining **Off...**
 - Select **RDA Control**
 - Select **VCP** in the Control/Status window
 - For Modify VCP: select **Adaptation**
 - Toggle Velocity Increment to **1.94 kts**
 - **Save, Download**, confirm changes, and **Close**
- Verify PRF #4 ($R_{\max} = 94 \text{ NM}$) remains set for all sectors

Note 1: If the VMI is .97 kt (1.94 kt), Table "Precip 8 / 0.97" ("Precip 8 / 1.94") from step 3 above applies for the 8 data level Velocity products.

Note 2: All coastal sites have been authorized to make this change to adaptation VCP 11 (and 21).

12. Reset the precipitation products to begin accumulating rainfall at the onset of the Tropical event. To accomplish this, the Nominal Clutter Areas (NCA) should be adjusted temporarily to **80000 km²**.

- Select **Precip Cat** and note the values of 'Detect' for each of the three categories.
- Select **Modify Parameters**, click within the 'NCA' box for the first 'Tilt Domain', Select **Modify**, change the value to **80000**, and select **Apply**.
- Next, click within the 'NCA' box for the second 'Tilt Domain', select **Modify**, change the value to **80000**, and select **Apply**.
- Finally, click within the 'NCA' box for the last 'Tilt Domain', select **Modify**, change the value to **80000**, and select **Apply**.
- **Save**, confirm changes, and **Close**.

Note: One hour must now elapse before the precipitation products will be reset (monitor the "Time Until Clear Air" line within the 'Precipitation Status' window). Once the clock reaches "0" minutes and the precipitation products reset,

remember to re-adjust the NCA's back to minimal values.

Alternate method (since one or two volume scans of data will be lost due to an RPG reboot, ensure this step is performed prior to any weather concerns):

- From the RPG **Control** menu, click **Off** under Shutdown and confirm
 - When the State shows as "Shutdown", click **Options** under Restart.
 - Unlock the screen using the **URC** password.
 - Select **Hydromet (excludes Gage Database)**, then **Activate** and confirm.
 - **Close** the Options Window, select **All Tasks** under Restart, and confirm.
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13. For sites still recording Archive Level II data by tape, ensure the device remains active. For non-collocated RDA/WFO sites, plan ahead to ensure the Archive II jukebox is loaded with new tapes.

From AWIPS:

14. It is strongly encouraged that local data archival is performed.

15. Initiate "radar multiple requests" to adjacent radar sites. Continuously monitor adjacent sites since significant tropical cyclone phenomena are based in the lower levels, and the closest radar will sample the environment best.

16. A set of suggested "minimum RPS lists" were originally developed when RPS lists were confined to only 20 products. However, the fundamental philosophy remains the same as operators interrogate tropical cyclones based on range from the radar and intensity. **Ensure that your WSR-88D RPS list on AWIPS includes the products on the suggested lists (below).**

Also, Storm Relative Velocity products (SRR, SRM) should be generated often via One-Time Requests with individual or field motions manually input by the radar operator. The algorithms may not be able to produce a useful motion on their own due to the rotational aspects of tropical cyclones.

Minimum recommended RPS list: Center more than 124 nmi from radar

Product	Elevation Angle (degrees)	Data Resolution (nautical miles)	Data Levels
Base Reflectivity	0.5	1.1	16
	1.5	1.1	16
	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	3.4	.54	16
Base Velocity	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	0.5	.54	8
Composite Reflectivity		.54	16
Vertically Intergrated Liquid			
Storm Total Precipitation			

Minimum recommended RPS list: Center 62-124 nmi from radar

Product	Elevation Angle (degrees)	Data Resolution (nautical miles)	Data Levels
Base Reflectivity	0.5	1.1	16

	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	3.4	.54	16
	6.0	.54	16
Base Velocity	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	3.4	.54	16
	0.5	.54	8
Composite Reflectivity		.54	16
Vertically Integrated Liquid			
Storm Total Precipitation			

Minimum recommended RPS list: Center 32-62 nmi from radar

Product	Elevation Angle (degrees)	Data Resolution (nautical miles)	Data Levels
Base Reflectivity	0.5	1.1	16
	0.5	.54	16
	1.5	.54	16
	2.4	.54	16

	3.4	.54	16
	6.0	.54	16
Base Velocity	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	3.4	.54	16
	0.5	.27	16
	1.5	.27	16
	0.5	.54	8
Composite Reflectivity		.54	16
Vertically Integrated Liquid			
Storm Total Precipitation			

Minimum recommended RPS list: Center 0-32 nmi from radar

Product	Elevation Angle (degrees)	Data Resolution (nautical miles)	Data Levels
Base Reflectivity	0.5	1.1	16
	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	3.4	.54	16

	6.0	.54	16
	9.9	.54	16
Base Velocity	0.5	.54	16
	1.5	.54	16
	2.4	.54	16
	3.4	.54	16
	0.5	.27	16
	1.5	.27	16
	0.5	.13	16
	0.5	.54	8
	1.5	.54	8
Composite Reflectivity		.54	16

Vertically Integrated Liquid

Storm Total Precipitation

Note: *This document is a living document and will be updated as necessary (e.g., due to new research or software changes).* For the most recent version, see http://www.ofcm.noaa.gov/nhop/03/pdf/nat_trop_cyc_wsr-88d_ops_plan.pdf

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